DOCUMENT RESUME

ED 472 988 SE 067 288

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TITLE Stars: Evaluating the Use of Video Technology for Modelling Science Process Skills.

PUB DATE 2001-06-00

NOTE 20p.; In: Proceedings of the Annual Meeting of the Association for the Education of Teachers in Science (Costa Mesa, CA, January 18-21, 2001). For full proceedings, see ED 453 083.

PUB TYPE Reports - Research (143)

EDRS PRICE EDRS Price MF01/PC01 Plus Postage.

DESCRIPTORS Classroom Techniques; *Educational Technology; Elementary Education; Models; Science Education; *Science Process Skills; Teaching Methods; Video Equipment; *Visual Aids

ABSTRACT

This paper describes a project that investigates elementary school students' behavioral changes using video as a modeling tool and examines the teaching behavior of teachers. For this purpose, videotaped images of culturally diverse children displaying appropriate behavior engaged in inquiry science were used. These images serve as peer role models for students. Results suggest that there is support for the use of video materials although no classroom management value is associated with the use of video models. (Contains 16 references.) (YDS)

STARS: EVALUATING THE USE OF VIDEO TECHNOLOGY FOR MODELLING SCIENCE PROCESS SKILLS

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This project explored the feasibility of developing a mechanism by which elementary children were given the opportunity to observe positive role models of appropriate children's behavior in a science classroom. A series of videotapes and instructional manuals were developed to support the needs of teachers and students to develop skills among students consistent with those required to participate in an inquiry-based science program. Staff development programming was developed to assist teachers in the implementation of the materials, and a subsequent series of classroom observations examined the value of the materials in terms of the nature of teacher-student classroom interactions.

The authors of this paper have both recently returned from observing student teachers. It was evident that both preservice and practicing teachers were disinclined to teach science in a manner consistent with the hands-on/minds-on approach advocated by the American Association for the Advancement of Science (AAAS, 1989), the National Research Council (NRC, 1996) and the State of Illinois Learning Goals (Illinois State Board of Education, 1997). Their objections typically related the difficulty in establishing classroom behaviors that will enable children to participate effectively in a classroom where individual autonomy, freedom and manipulation of materials are the norm (King, Shumow, & Leitz, 2000; 2001). Lynes and Oshita (1998) report similar

findings from their work with science teachers, that the need for student autonomy, classroom management issues, and a inquiry-based approach to learning science.

When teachers are asked to comment on why they are reluctant to have children manipulate materials in a hands-on science program, their responses typically included: discipline gets out of hand, children can't handle the freedom, it takes too much time, children can't work with other children, or it is too noisy (King, Shumow, & Leitz, 2000; 2001). To address these obstacles to hands-on/minds-on science instruction, providing a set of model behaviors for students to emulate would do much to address the needs of both teachers and students.

Classroom teachers who were reluctant to have their students participate in a hands-on science program will show those images to their elementary students. By showing video images of young children engaging in appropriate behavior that is associated with inquiry science investigations, other children will then find a peer role model to model their own behaviors. This project videotaped images of culturally diverse children engaged in different aspects of inquiry science. Documentation to support the use of these videos in the classroom was developed for use with the videotaped materials (King & Thompson, 1999a; 1999b; Thompson & King, 1999).

Research Questions

To organize provide focus for this study, the following research questions were developed:

(1) *Is there an increase in higher-level classroom discourse that correlates with the use of the instructional materials?* This is important, as the value of the material is to

focus classroom interactions on the behaviors consistent with inquiry-based classroom instruction.

(2) *Do the level of classroom management interactions remain constant during the school year as a result of the use of the instructional materials?* Findings cited elsewhere in this paper show that an increase (often dramatic) in classroom management interactions is related to students participating in an inquiry-based set of classroom experiences (King, Shumow, & Lietz, 2000). Keeping classroom interactions at the same level as during expository teaching (or finding a decrease) is desirable for teachers and students engaging in hands-on/minds-on science.

(3) *Is there an optimum combination of instructional materials that supports improvement in classroom interactions?* This question examines the materials students were exposed to during the treatment portion of the investigation. Students were given the opportunity to view video episodes of students using inquiry skills, perform activities using inquiry skills, or a combination of the two experiences.

Experimental Design

The design selected for this investigation is outlined in Table 1 below. Four conditions were selected for examining the value of the instructional materials. Eight classrooms participated in the study. Two classrooms were randomly assigned to each of the conditions. This design allows for effective control of internal and external validity issues (Campbell & Stanley, 1963).

Table 1.

Experimental conditions for project evaluation

Initial Observation	Video	Activities	Subsequent Observations
1. RO_1			O_2 $O_{2'}$
2. RO_3	X		O_4 $O_{4'}$
3. RO_5		X	O_6 $O_{6'}$
4. RO_7	X	X	O_8 $O_{8'}$

Condition 1 provided the control group. Two teachers participated in the September 1999 workshop, but did not use any of the instructional materials during the school year. An initial observation (O_1) took place during October 1999, shortly before the workshop. Subsequent observations (O_2 and $O_{2'}$) took place during November and January. Condition 2 represented exposing students to the video materials only, with an initial and then three post-treatment observations. Condition 3 represents exposing students only to the activities in the instructional manual that develop through hands on interaction with activities that focus on the process skill. Condition 4 captures students using both the video materials and the associated hands-on activities.

Theoretical Implications and Relations to Previous Work

This study examines issues in two areas: the use of video as a modeling tool and the examination of teaching behaviors through a methodology examining levels of instructional discourse developed by Shumow (1998). The modeling feature of the project was employed through the use of the videotaped process skill episodes and the classroom observations recorded changes in behavior resulting from the video experiences.

Modeling

The value of modeling as a teaching and learning tool is evident, as demonstrated in the work of Bandura (1986). For these models to work most effectively, they must be perceived by the viewer as being believable. The models must also demonstrate behaviors that can be incorporated by the viewer. By using elementary students as models, it is anticipated that the behaviors demonstrated by the student models captured on video will provide a model for behaviors desired of elementary students participating in inquiry-based science investigations. The act of modeling is critical in science education as well. Brna and Burton (1997) further made a case for modeling as an essential part of the science education experience. White and Fredricksen (1998) have advocated developing curricula that supports this process in science teaching. The materials developed for this study not only provide behavioral models for students, but the students in the video also help to model the role of modeling in inquiry-based science activities.

Classroom Discourse

Examining classroom behaviors through an objective means provided the method of examining classroom practices for changes promoted by the use of the video materials. The coding scheme employed was previously modified from prior observational studies of adult teaching of elementary school students within the framework of NCTM mathematics reforms (Lehrer & Shumow, 1997; Shumow, 1998). This scheme focused on a number of the instructional strategies suggested by the science reform documents and entails coding each statement that the teacher made during the lesson on two

dimensions. The first dimension, "involving", characterized (yes/no) whether the teacher's statement prompted the students to engage in (higher order) thinking.

The second dimension, called "purpose," categorized the function the teacher's statement served in the lesson. These purposes include focusing on either a) knowledge, givens, or problem definitions, b) moving the flow of the lesson forward, c) elaborating including hypothesizing, comparing and contrasting, explaining, or justifying, d) modeling including demonstrating, creating representations, or analogizing, e) managing student behavior, and f) attending to interruptions.

It is an assumption by the authors of this study that the behaviors captured (levels of discourse) were impacted by the exposure to the instructional materials. Given that the skills associated with inquiry-based science instruction are consistent with those behaviors described in the coding scheme, it is reasonable to infer that changes in teacher-student interactions will be captured by the methodology.

Background on the Participants and Schools

The participants in the study were selected from among the teachers and students in School District U-46, in Elgin, IL. School District U-46 is the second largest school district in the state of Illinois. It is a vast and varied district, with a large number of students from underrepresented populations and a wide range of socioeconomic levels. In 1998, U-46 served over 34,000 students. The district reported that some 66 different languages were spoken among U-46 students in a recent school district census. Approximately 26% of U-46 students are of Hispanic origin, 8% are African-American, 6% are Asian-American, and less than 1% are Native American (School District U-46,

1999). The students participating in the investigation reflect the overall demographics of the school district.

Procedure

The procedure employed in this study was carried out in two phases: staff development and classroom implementation. The staff development process trained all of the participating teachers in the use of the materials. An instructional manual accompanied each video, with suggestions as to how to use the videotapes as a discussion and modeling guide. Contained in the manual were a set of activities to profile the essential issues of the process skills covered in each tape. Teachers viewed the tapes with the guidance of the project developers and discussed how to use them to foster knowledge of the process skills. Teachers also experienced the science activities suggested in each instructional manual as a means of further developing their own understanding of science inquiry skills. At the conclusion of the workshop, the teachers were randomly assigned to one of four experimental conditions.

Prior to the workshop, each of the teachers was videotaped teaching a science lesson. This lesson was used to provide a baseline for each of the classes observed. After the workshop, the teachers and their classes were videotaped three subsequent times, to look for changes over time. The videotapes were analyzed and the teacher-student interactions classified according to the observation scheme described previously.

Results

The results are summarized in Tables 2 - 9 below.

Table 2.

The instructional functions served by each teacher's classroom discourse. (Control groups*)

	Teacher 1		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	26.4	28.9	15.6
Sequential Flow	41.1	51.6	59.7
Elaboration	11.7	2.4	9.4
Modeling	0	5.1	3.9
Classroom Management	20.8	12.0	11.4

*Note. The lessons were approximately 40 minutes in length.

The second set of control group observations is summarized in Table 3. Teachers in this group showed increased in sequential flow interactions and modeling interactions. Information focus, elaboration, and classroom management instructional interactions all decreased during the time of the study.

The second classroom serving as a control for the investigation demonstrated increases in sequential flow and modeling measures. Information focus, elaboration, and classroom management interactions all showed decreases during the period of the investigation.

Table 3.

The instructional functions served by each teacher's classroom discourse. (Control groups*)

	Teacher 2		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	26.0	24.1	15.1
Sequential Flow	47.6	51.6	72.0
Elaboration	17.9	11.0	8.2
Modeling	0	6.2	2.2
Classroom Management	8.5	7.2	2.5

*Note. The lessons were approximately 40 minutes in length.

Teacher 3, who made use of both the videotapes and the process skill activities demonstrated interactions with students showed increases in elaboration, modeling, and classroom management interactions. Over the period of the investigation, sequential flow remained essentially unchanged (moving from 64.0 to 63.5 percent of observed interactions over the period of the study). Decreases were observed in the construct of information focus.

Table 4.

The instructional functions served by each teacher's classroom discourse. (Both treatments*)

	Teacher 3		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	32.5	23.1	20.6
Sequential Flow	64.0	69.8	63.5
Elaboration	0.6	3.9	5.8
Modeling	0	2.0	1.1
Classroom Management	2.9	1.2	9.0

*Note. The lessons were approximately 40 minutes in length.

Table 5.

The instructional functions served by each teacher's classroom discourse. (Both treatments*)

	Teacher 4		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	23.0	19.5	10.3
Sequential Flow	54.6	64.3	70.0
Elaboration	9.5	7.5	11.5
Modeling	5.0	0.9	1.0
Classroom Management	6.7	7.9	7.3

*Note. The lessons were approximately 40 minutes in length.

Teacher 4 also made use of both the video materials and the activities. Observations show an increase in terms of the sequential flow, elaboration, and classroom management constructs. Information focus and modeling both decreased.

Table 6.

The instructional functions served by each teacher's classroom discourse. (Activities alone*)

	Teacher 5		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	30.7	32.8	37.0
Sequential Flow	45.7	42.9	44.5
Elaboration	10.6	18.4	11.1
Modeling	1.4	0.7	1.7
Classroom Management	12.2	5.1	5.6

*Note. The lessons were approximately 40 minutes in length.

Teachers 5 and 6 used only the process skill activities to provide instructional models for their students. In the case of Teacher 5, a 6.3 percent increase in modeling utterances was observed, as well as smaller (0.5 and 0.3, respectively) increases in elaboration and modeling. Sequential flow decreased slightly, and classroom management utterances decreased by over 6 per cent.

Teacher 6 taught in a bilingual classroom. English was not used in classroom instruction in science. For these observations, information focus remained constant over

the time of observations (including one dramatic drop before returning to pre-treatment observation levels). Sequential flow and modeling both decreased. Elaboration and classroom management interactions both increased.

Table 7.
The instructional functions served by each teacher's classroom discourse. (Activities alone*)

	Teacher 6 (Bilingual)		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	22	7.3	22
Sequential Flow	53.8	59.2	47
Elaboration	5.5	15.5	15
Modeling	14.3	6.8	7
Classroom Management	5.5	4.9	9

*Note. The lessons were approximately 40 minutes in length.

Tables 8 and 9 present the instructional functions observed in classes that applied the process skill activities alone. Teachers 7 and 8 made use only of the video materials to expose their students to science process skills. For teacher 7, increases were observed in information focus, (very slightly) in sequential flow, in elaboration, and in modeling. A decrease in classroom management utterances was observed simultaneously.

Teacher 9, another bilingual teacher, made use of the video materials in a classroom in which English was not used during instruction. Decreases were observed during the study period in the areas of information focus, elaboration, modeling (and

slightly) in classroom management. A large increase in the sequential flow construct (from 42 to 65.9 per cent) of utterances was observed during the same time frame.

Table 8.
The instructional functions served by each teacher's classroom discourse. (Video alone*)

	Teacher 7		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	15.6	8.3	16.6
Sequential Flow	66.2	74.4	66.5
Elaboration	4.0	8.7	6.7
Modeling	2.0	0.6	4.3
Classroom Management	12.1	7.9	6.0

*Note. The lessons were approximately 35 minutes in length.

Table 9.
The instructional functions served by each teacher's classroom discourse. (Video alone*)

	Teacher 8 (Bilingual)		
	Pre-treatment Observation	Post-treatment Observation (1)	Post-treatment Observation (2)
Information Focus	34.2	35	19
Sequential Flow	42	43.2	65.9
Elaboration	9.5	3	6.3
Modeling	8.2	12.1	3.2
Classroom Management	8.2	7.6	7.9

*Note. The lessons were approximately 35 minutes in length.

Discussion

The essential areas of interest in this study were in three areas: to examine changes in the elaboration construct, in classroom management, and whether an optimum combination of video/activity experiences produces viable changes within the above-noted classroom behaviors.

Table 10.

Summary of changes in teacher discourse

Treatment Condition	Elaboration (percentage change)	Classroom Management Interactions (percentage change)
Control (1)	-2.3	**-9.4**
Control (2)	-9.7	**-6.0**
Video/activity (1)	**5.2**	6.1
Video/activity (2)	**2.0**	0.6
Activities alone (1)	**0.5**	**-6.6**
Activities alone (2)*	**9.5**	3.5
Video alone (1)	**2.7**	6.1
Video alone (2)*	-3.2	**-0.3**

Bold indicates the desired direction of the change in terms of improved classroom experiences

*Bilingual classrooms

The findings of the study provide a number of points of interest for discussion. Before addressing the general considerations, the results with respect to the research questions will start the discussion.

The first research question looked for an increase in the presence of higher order thinking skills as a function of the experimental condition. This construct was captured by the *elaboration* category. There is *support* for this position during observation period. The changes observed in the elaboration construct support this position. Each of the experimental conditions demonstrated *some* increase in the presence of elaboration, save for one classroom. The combination of video materials and activities were identified with the increases in the construct of elaboration during the classroom interactions. In addition, the group that used the activities alone also demonstrated increases in the frequency of the modeling construct during the observation period. Among the video-only groups, an increase was observed in the English language group, but not among the Spanish-speaking group. As the videos were produced in English, this finding is not surprising. This magnitude of this effect is compounded by the *decrease* in the frequency of this construct over time in the control group. In sum, there is *support* for the position that the use of the use of video materials, at least in terms of learners sharing the same language as the models on the videos.

The second research question examined changes in the role of classroom management concerns as a function of the instructional materials. From the data related to this construct, there is *no* support, at this point to suggest that the infusion of the materials at the beginning of the school year had lasting effects towards decreasing classroom management interactions. The greatest decrease in classroom management interactions, in fact, took place in the classrooms serving as the control for the investigation. In fact, the video models of the activities could be argued to have had a deleterious influence on classroom practices as demonstrated by the data presented. The

only instance in which a positive change in classroom management interactions was associated with the use of the videotapes was with the bilingual class. The position with respect to this research question is that there is *no* classroom management value associated with the use of the video models.

The final research question sought evidence of an optimum combination of conditions regarding the use of the instructional materials. The data seem quite mixed in terms of the findings. The most definitive statement that can be made is that students benefited from the use of video, activities, and the combination of videos and activities when compared to the control group—in terms of the elaboration construct. Interestingly, the students in these classes also demonstrated the largest decrease in classroom management-related interactions. Perhaps the role of modeling among students in the video and derived also from the classroom activities produces added stresses to the teacher's classroom interactions, resulting in a higher degree of management-type statements from the teacher. In response to this research question, no definitive answer has been obtained.

Teacher comments during post-study interviews provided both support for the use of the materials and insights into the materials. Typical responses included:

- Great model for the children
- Great model for teachers
- Discussions afterwards were very beneficial to children
- They showed real classes working
- Students [in the videos] explained the concepts
- Multicultural context [was helpful]

- Students were able to see examples of process skills being used by peers

These were consistent with what the developers of the materials had anticipated would be the strengths of the video materials. The intent of modeling found a role not only for the students, as had been anticipated, but in the comments of one teacher, in served the purpose of modeling inquiry practices for teachers as well.

The weaknesses of the materials, as recounted by teachers, included the following:

- There were quite a few times we had to stop and explain to students. Some concepts in the video were above their heads.
- There were not [any] weaknesses....I teach second grade bilingual, and ...the first one worked great, even for the non-English speakers

It is interesting that the teacher comments above, that "the first one worked great, even for non-English speaker" was made, as one of the desired outcomes of the project—that increases in elaboration-related interactions—was not observed in her classroom. Teachers in the experimental groups consistently found that the video materials helped to address their instructional needs, whether or not actual changes were observed. From this perspective, if the materials give the teachers more confidence to teach science, then instructional aides such as this might find an important home in classrooms where the teaching of science is a less-than-universal experience. This was further expanded upon by several teachers who stated that "more of the videos would be helpful" and a desire for the materials to be offered in Spanish, as well as a set for multiple grade levels. Related to the idea of more videos was one statement that more of the videos be produced so as to be used throughout the year, as opposed to the intensive,

one-week use applied in this investigation. A further comment, echoing the request for more videos, suggested further that they be developed to precisely complement the existing curriculum, as opposed to a more general set of process skills videos.

Further investigation with materials of this sort are clearly warranted. Using the same materials in a modified setting—e.g., using the videos with the classes, but spacing the viewings several weeks apart might be helpful in producing more lasting effects. Too, conducting observations at more nominally "normal" times in the school year—removed from testing and spring break—might demonstrate more worth for the use of video modeling for process skills. Our work will continue to investigate the means by which to optimize the time and science learning of students.

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Author Note

Our gratitude is extended to the teachers and students of School District U-46, Elgin, Illinois and the Media Services Department at Northern Illinois University for invaluable assistance. Further support from the Illinois State Board of Education and Northern Illinois University is gratefully acknowledged and appreciated.

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